

Technical Information

CK8167/ 4CX300A

CERAMIC TETRODE RF POWER AMPLIFIER OR OSCILLATOR

The Raytheon CK8167/4CX300A is a power tetrode of metal–ceramic construction, designed with an external anode and integral cooling fins. In combination with the unique basing, this provides useful operation up to 500 megacycles in typical oscillator, linear amplifier and class C power amplifier service.

Compact mechanical design and forced air–cooling assure dependable performance under severe environmental conditions of temperature, vibration and shock as well as long standby periods.

CK8167/4CX300A is manufactured and controlled to meet the requirements of the applicable MIL–E–1 specification.

ENVIRONMENTAL RATINGS (ABSOLUTE MAXIMUM):

Temperature (seal)	250	°C
Temperature (anode core)	250	°C
Altitude	10000	ft.

ELECTRICAL DATA

HEATER CHARACTERISTICS:

Heater voltage – See application note 1	6.0	Volts
Heater current	2.85	Amps

DIRECT INTERELECTRODE CAPACITANCES:

Input	29.0	pf
Output	4.0	pf
Grid to plate (max.)	0.06	pf
C k to g1 (p, g2, and h grounded)	16.0	pf
C p to (g1 + h + g2) (k grounded)	4.0	pf
C k to p	0.01	pf

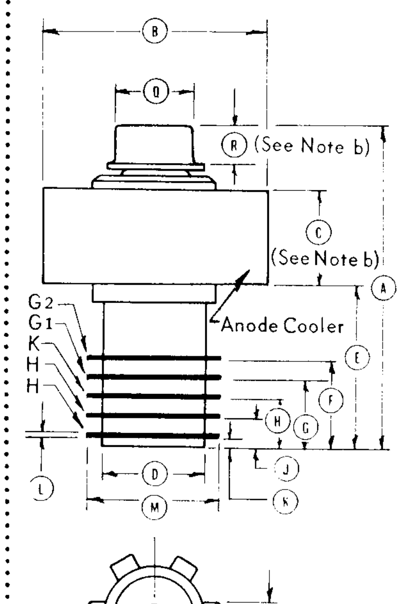
RATINGS – ABSOLUTE MAXIMUM (CCS):

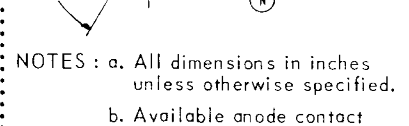
Class:	C telegraphy	C telephony	AB1	
Heater voltage, See note 1	6.0 ± 5%	6.0 ± 5%	6.0 ± 5%	Vac
Plate voltage	2000	1500	2500	Vdc
Screen voltage	300	300	400	Vdc
Grid #1 voltage	–250	–250	–250	Vdc
Plate current	250	200	250	mAdc
Plate dissipation, See note 2	300	200	300	W
Screen dissipation	12	12	12	W
Grid #1 dissipation	2	2	2	W
Plate input power	500	300	625	W
Heater–cathode voltage				
Heater negative to cathode	150	150	150	Vdc
Heater positive to cathode	150	150	150	Vdc

MECHANICAL DATA

BASE	Special, see below
OUTLINE	See below
RECOMMENDED SOCKET	Eimac SK–700 series or equivalent
OPERATING POSITION	Any
COOLING	Forced air
CATHODE	Coated, unipotential

OUTLINE AND BASING





NOTES : a. All dimensions in inches unless otherwise specified.

b. Available anode contact surface.

PHYSICAL DIMENSIONS

	MIN.	MAX.
A	2.300	2.500
B	1.610 dia	1.640 dia
C	0.710	0.790
D	0.740 dia	0.770 dia
E	1.133	1.195
F	0.602	0.642
G	0.470	0.500
H	0.329	0.359
J	0.193	0.213
K	0.050	0.072
L	0.010	0.020
M	0.936 dia	0.956 dia
N	0.170	0.185
P	60° nom.	
Q	0.559 dia	0.573 dia
R	0.240	0.280

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ELECTRICAL DATA (Cont'd.)

GENERAL RATINGS:

Maximum frequency for full input power – See application note 1	500 Mc
Cathode conditioning time (tk)	
Nominal	60 sec
Absolute minimum	30 sec
Amplification factor (G1 to G2)	4.8
Transconductance at Ib = 200 mAdc	12000 μmho

TYPICAL OPERATIONS:

RADIO–FREQUENCY POWER AMPLIFIER OR OSCILLATOR – CLASS C

					See Note 7	
Plate voltage	500	1000	1500	2000	2000	Vdc
Screen grid voltage, see note 3	250	250	250	250	250	Vdc
Grid voltage	–90	–90	–90	–90	–90	Vdc
Plate current	250	250	250	250	250	mAdc
Screen grid current (approx.)	45	38	21	19	10	mAdc
Grid #1 current (approx.)	35	31	28	26	25	mAdc
Peak RF grid voltage (approx.)	114	114	112	112	---	v
Driving power (approx.), see note 5	4.0	3.5	3.2	2.9	---	W
Plate Input Power	125	250	375	500	500	W
Useful power output (approx.), see note 6	67	180	265	370	225	W
Heater voltage (note 1)	6.0	6.0	6.0	6.0	5.5	Vac

AUDIO FREQUENCY AMPLIFIER OR MODULATOR, CLASS AB1 (TWO TUBES IN PUSH–PULL)

Plate voltage	1000	1500	2000	2500	Vdc
Screen voltage, see note 3	350	350	350	350	Vdc
Grid voltage, see note 4	–55	–55	–55	–55	Vdc
Zero signal plate current	200	200	200	200	mAdc
Max. signal plate current	500	500	500	500	mAdc
Max. signal screen grid current	20	16	10	8	mAdc
Effective load resistance	3500	6200	9500	11600	ohms
Peak AF G1 to G1 voltage (approx.)	100	100	100	100	v
Driving power	0	0	0	0	W
Max. signal power output	240	430	600	800	W

RADIO FREQUENCY LINEAR AMPLIFIER, SINGLE SIDE BAND

SUPPRESSED–CARRIER OPERATION (SINGLE TUBE), FREQ. UP TO APPROX. 175 Mc/s CLASS AB1

SINGLE TONE AND/OR TWO TONE OPERATION

Plate voltage, note 8	1000	1500	2000	2500	Vdc
Screen grid voltage, see notes 3 and 8	350	350	350	350	Vdc
Grid voltage, see note 4	–55	–55	–55	–55	Vdc
Zero signal plate current	100	100	100	100	mAdc

ELECTRICAL DATA (Cont'd.)

RADIO FREQUENCY LINEAR AMPLIFIER, SINGLE SIDE BAND (Cont'd.)

SINGLE TONE MODULATION

Max. signal plate current	250	250	250	250	mAdc
Max. signal screen grid current	10	8	5	4	mAdc
Max. sig. peak RF grid voltage (approx.)	50	50	50	50	v
Max. signal grid current	0	0	0	0	mAdc
Useful power output (approx.), see note 6	115	205	285	380	W

TWO TONE MODULATION

Peak Envelope conditions for a signal having a min. peak–to–average power ratio of 2.

Ave. plate current	190	190	190	190	mAdc
Ave. screen current (approx.)	2	–1	–2	–2	mAdc
Ave. grid #1 current	0	0	0	0	mAdc
Resultant peak RF grid voltage	50	50	50	50	v
Peak envelope power output, see note 6	115	205	285	380	W

PLATE–MODULATED RADIO–FREQUENCY AMPLIFIER CLASS C

Plate voltage	500	1000	1500	Vdc
Screen voltage	250	250	250	Vdc
Grid voltage	–100	–100	–100	Vdc
Plate current	200	200	200	mAdc
Screen current (approx.)	31	22	20	mAdc
Grid #1 current	15	14	14	mAdc
Peak RF grid input voltage (approx.)	118	117	117	volts
Driving power, see note 5	1.8	1.7	1.7	W
Plate input power	100	200	300	W
Useful power output, (approx.) Note 6	57	138	223	W

APPLICATION NOTES

Note 1. At frequencies above approximately 200 megacycles it may be necessary to reduce heater voltage to compensate for rf transit time heating of the cathode after dynamic operation of the tube has started. This back heating is a function of frequency, grid current, grid bias, anode current, duty cycle, and circuit design and adjustment. Particular care should be used in the selection of stable circuit components and in final tuning of high–frequency circuits as off–resonance operation, even to a small degree, may result in a marked and undesirable increase in cathode temperature. There is an optimum heater voltage which will maintain the cathode at the correct operating temperature for any particular set of operating conditions. A maximum variation of ±5 percent from optimum is permitted. For straight through, Class C CW amplifier operation, the following heater operation voltages are indicated:

Frequency (Mc)	Ef(Vac)
201 to 300	5.75
301 to 400	5.50
401 to 500	5.00



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APPLICATION NOTES (Cont'd.)

Note 2. When the tube is operated at 100 percent of maximum rated plate dissipation at an incoming air temperature of 25°C maximum, a minimum air flow of 5.0 cfm at sea level shall pass through the anode cooler. If the socket Drawing Eimac No. SK–710, or equivalent, is used, an incoming air flow of 5.0 cfm to the lower end of the socket is required. At this flow of 5.0 cfm, the static pressure drop directly across the tube and socket is approximately 0.4 inch of water. This pressure drop varies with the amount of escaping air and with the shape and construction of the air director. The air flow rating applies at bias voltages of less than 100 volts and frequencies of less than 500 Mc. Air cooling of the tube shall be increased with increased negative grid bias, increased incoming air temperatures, or increased frequency of operation, or a combination of both. In all cases of operation, a socket which provides forced–air cooling of the base shall be used, and maximum seal and anode core temperature ratings shall not be exceeded. The air flow shall be applied before or simultaneously with electrode voltages, and may be removed simultaneously with them.

Note 3. Since screen grid current may be reversed under certain operating conditions, precautions must be taken to assure the proper maintenance of screen grid voltage. Recommended methods are the use of a stiff voltage divider or of a regulated screen voltage. Conversely the use of a screen dropping resistor for obtaining proper screen voltage is not recommended.

Note 4. To obtain indicated zero–signal plate current, adjust grid bias.

Note 5. Driving power values are approximately correct at low frequencies. At high frequencies, approaching the maximum capabilities of the tube, electron transit time losses and other tube and circuit losses increase rapidly. It is therefore generally necessary to use a driver stage capable of supplying from 2 to 10 times the values shown.

Note 6. The values for "Useful Power Output, approx." are based upon an output circuit efficiency of 95%.

Note 7. Typical values obtained in a 450–500 Mc cavity amplifier per JAN Dwg. 285 or equivalent. Power output is the minimum measured useful power output.

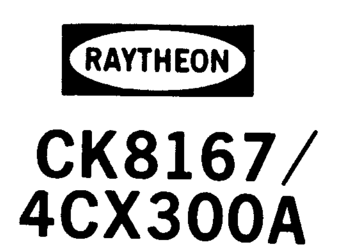
Note 8. For the maximum signal to intermodulation distortion ratio (S/D), it is recommended that low impedance regulated supplies be used for grid bias and screen voltage.

CHARACTERISTIC RANGES AND CONTROLS:

Test Conditions, except where otherwise specified.
$Ef = 6.0$ Vac; $Ebb = 1000$ Vdc; $Ec_2 = 300$ Vdc; $Ec_{1/Ib} = 150$ mAdc
Values are initial, unless otherwise noted.

PRODUCTION TESTS: (Insp. Level II, 0.65% AQL individual tests, 1% all tests combined).

	MIN.	MAX.	
Screen grid current	–5.0	+3.0	mAdc
Grid #1 voltage (Initial and post Vibration Noise and Shock limit)	–32.0	–46.0	Vdc
Total grid current (Ebb = 2000 Vdc)	---	–15.0	µAdc
Post vibration noise, shock and 100 hour life test (3) limit	---	–20.0	µAdc
Primary control grid emission			
$Ic_1 = 70$ mAdc, t = 15; anode and screen grid floating.			
Initial and 500 hour life test (1) limit	---	–25	µAdc
Primary screen grid emission			
$Ec_1 = 0$ Vdc; $Ic_2 = 100$ mAdc; t = 15; anode floating.			
Initial and 500 hour life test (1) limit	---	–250	µAdc
Heater current, initial	2.60	3.10	Aac
Life test (4) 200 hour limit	2.20	3.20	Aac



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CHARACTERISTIC RANGES AND CONTROLS (Cont'd):

PRODUCTION TESTS: (Cont'd.)	MIN.	MAX.	
Pulse emission (1)			
$Eb = Ec_2 = 250$ Vdc; $Ec_1 = -100$ Vdc; $e_{gk/ik} = 1.5a$			
$Ef = 5.4$ Vac; prr = 11 ± 1 cps; tp = 4,500 μsec.			
Δik (from leading edge to trailing edge) shall not exceed	---	200	ma
Positive grid current division			
$Eb = Ec_2 = 250$ Vdc; $Ec_1 = -100$ Vdc; egk/Ib = 1.0a;			
prr = 11 ± 1 cps; tp = 4500 μsec			
egk	+8.0	+18.0	v
ic1	---	250	ma
ic2	---	250	ma
DESIGN TESTS: (Lot Sampling, Insp. Level L6, 6.5% AQL)			
Direct interelectrode capacitance			
Grid to plate (max.)	---	0.06	pf
Input	25.0	33.0	pf
Output	3.5	4.5	pf
Pulse emission (2)			
Eb = Ec2 = 250 Vdc; Ec1 = −100 Vdc; $egk/_{ik} = 1.5a$,			
Ef = 6.0 Vac; prr = 11 ± 1 cps; tp = 4500 μsec. Maximum			
Δik (from leading edge to trailing edge) initial, 500 hour			
life test (1) and 100 hour life test (3) limit	---	100	ma
Power output			
Class C amplifier; F = 450 to 500 $Mc/_s$; Ebb = 2000 Vdc;			
$Ec_1 = -90$ Vdc; $Ec_2 = 250$ to 300 Vdc; $Ic_1 = 25$ mAdc max.;			
Ef = 5.0 Vac; $Eg_{1/Ib} = 250$ mAdc. Circuit and cavity in			
accordance with drawing 285–JAN or equivalent	225	---	W
Heater–cathode leakage (Ehk = ± 250 Vdc)			
Initial 500 hour life test (1), and 200 hour life test (4) limit	---	150	μAdc

SPECIAL PERFORMANCE TESTS TO INSURE PRODUCT QUALITY

SHOCK TEST

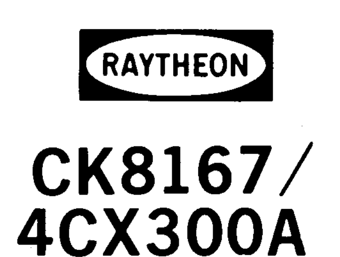
Impact acceleration = 50 G; duration = 11 ± 1 milliseconds; 18 total blows.

Sample is randomly selected from each production run and test is performed in three different positions. Shorts during test, whether permanent or temporary, are rejected as well as after the test. Tubes following tests also must meet initial limits for Grid Voltage and a maximum grid current limit of −20 μAdc.

VIBRATION NOISE TEST

Frequency range: 5 to 500 to 5 cps; acceleration = 20 G peak; t = 30 minutes total.

This test is performed on a randomly selected sample from each production run. Tubes are swept in each of three positions through the specified range, then vibrated for sixty seconds at the frequency which gives the maximum vibration output voltage. During test, vibration output limit (Ep) is 20 Vac. Following test, tubes must be free of shorts, permanent or temporary, and meet initial limits for Grid Voltage and a maximum grid current limit of −20 μAdc.



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SPECIAL PERFORMANCE TESTS TO INSURE PRODUCT QUALITY (Cont'd.)

LIFE TESTS

LIFE TEST (1) 500 hour test

This test is performed on a randomly selected sample, Group C, from each production run under Power Output conditions. Following this test, tubes will not show shorts or open circuits and pass initial limits for Pulse Emission (2), primary control grid emission, primary screen grid emission and heater cathode leakage.

LIFE TEST (2) 500 hour test

This test is operated at accelerated heater voltage (Ef = 6.6), no voltage on other elements on a randomly selected sample, Group C, from each production run. Tested a minimum of 30 minutes after Ef is turned off, tubes shall pass a minimum resistance limit of 100 Megs for Rg1g2 and Rg1k.

LIFE TEST (3) 100 hour test

This test is performed on a randomly selected sample, Group D, from each production lot at: F = 1 kc min.; Ebb = 1000 Vdc; Ec2 = 250 Vdc; Ec1/Ib = 50 mAdc; Eg1/Ib = 100 mAdc; Rp = 1000 ohms; T ambient = 200°C min. After 100 hours, tubes must be free of all shorts and open circuits and pass the initial limit for Pulse Emission (2) and a maximum Grid Current limit of −20 μAdc.

LIFE TEST (4) 200 hour test – Heater Cycling Life Test.

With normal test conditions on all elements except Ec1 = −100 Vdc, and heater voltage cycling 2 minutes ON and 4 minutes OFF, this test is performed on a randomly selected sample from each production run. No grid–cathode shorts are allowed during or after life test. In addition, after tests, tubes must pass initial limits for heater–cathode leakage and heater current limits of 2.2 to 3.2 Aac.



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TYPICAL CONSTANT CURRENT CURVES

Ec2 = 250 Vdc
Ib (Amps) ———
Ic2 (Amps) —·—·—
Ic1 (Amps) - - - -

Plate Voltage -- Volts

Grid #1 Voltage -- Volts



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TYPICAL CONSTANT CURRENT CURVES

Ec2 = 350 Vdc
Ib (Amps) ———
Ic2 (Amps) —·—
Ic1 (Amps) - - -

Plate Voltage – Volts

Grid #1 Voltage – Volts

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